Claims

What is claimed is:

1. A free piston engine comprising:

an energy generation and control assembly having a first side and a second side in opposed relation to the first side;

a first combustion cylinder assembly located adjacent to the first side and including a first cylinder liner having a generally cylindrical wall that defines a first engine cylinder, which is generally centered about an axis of motion, and with the wall including at least one exhaust port extending therethrough;

a second combustion cylinder assembly located adjacent to the second side and including a second cylinder liner having a generally cylindrical second wall that defines a second engine cylinder, which is generally centered about the axis of motion, and with the second wall including at least one second exhaust port extending therethrough;

an inner piston assembly including a first inner piston having a head portion, an opposed rear portion, and a cylindrical side wall extending therebetween, with the cylindrical side wall generally centered about and extending in the direction of the axis of motion, and with the first inner piston being located and telescopically slidable within the first engine cylinder along the axis of motion a generally predetermined distance that defines a first piston stroke; a second inner piston having a head portion, an opposed rear portion, and a second cylindrical side wall extending therebetween, with the second cylindrical side wall generally centered about and extending in the direction of the axis of motion, and with the second inner piston being located and telescopically slidable within the second engine cylinder along the axis of motion a generally predetermined distance that defines a second piston stroke; and a push rod mounted to the first inner piston and the second inner piston and operatively engaging the energy generation and control assembly; and

wherein the location in the wall of the at least one exhaust port is such

that the cylindrical side wall will cover the at least one exhaust port for only a portion of the first piston stroke, and the location in the second wall of the at least one second exhaust port is such that the second cylindrical side wall will cover the at least one second exhaust port for only a portion of the second piston stroke.

2. The free piston engine of claim 1 wherein the at least one exhaust port is a plurality of circumferentially spaced exhaust ports.

3. The free piston engine of claim 2 wherein the at least one second exhaust port is a second plurality of circumferentially spaced exhaust ports.

4. The free piston engine of claim 1 wherein the at least one exhaust port has an axial length extending in the direction of the axis of motion, and the axial length is about ten percent of the distance of the first piston stroke.

5. The free piston engine of claim 4 wherein the at least one second exhaust port has a second axial length extending in the direction of the axis of motion, and the second axial length is about ten percent of the distance of the second piston stroke.

6. The free piston engine of claim 1 wherein the wall of the first cylinder liner includes at least one intake port, spaced from the at least one exhaust port; and the engine further includes an external exhaust gas recirculation assembly having a heat exchanger with an inlet in fluid communication with the at least one exhaust port and an outlet in fluid communication with the at least one intake port.

7. The free piston engine of claim 6 wherein the second wall of the second cylinder liner includes at least one second intake port, spaced from the at least one second exhaust port, and the inlet of the heat exchanger is in fluid communication with the at least one second exhaust port and the

outlet of the heat exchanger is in fluid communication with the at least one second intake port.

8. The free piston engine of claim 6 wherein the heat exchanger has a capacity and the capacity is selectively variable.

9. The free piston engine of claim 1 further including an outer piston assembly having a first outer piston located and telescopically slidable within the first engine cylinder along the axis of motion and having a head portion that faces the first inner piston, a second outer piston located and telescopically slidable within the second engine cylinder along the axis of motion and having a head portion that faces the second inner piston, and an outer rod mounted to the first and second outer pistons and operatively engaging the energy generation and control assembly.

10. A method of operating a free piston engine comprising the steps of:

providing an energy generation and control assembly having a first side and a second side in opposed relation to the first side;

providing a first combustion cylinder assembly located adjacent to the first side and including a first cylinder liner having a generally cylindrical wall that defines a first engine cylinder, which is generally centered about an axis of motion, and with the wall including at least one exhaust port extending therethrough;

providing a second combustion cylinder assembly located adjacent to the second side and including a second cylinder liner having a generally cylindrical second wall that defines a second engine cylinder, which is generally centered about the axis of motion, and with the second wall including at least one second exhaust port extending therethrough;

providing an inner piston assembly including a first inner piston having a head portion, an opposed rear portion, and a cylindrical side wall extending therebetween, with the cylindrical side wall generally centered about and extending in the direction of the axis of motion, and with the first inner piston

being located and telescopically slidable within the first engine cylinder along the axis of motion; a second inner piston having a head portion, an opposed rear portion, and a second cylindrical side wall extending therebetween, with the second cylindrical side wall generally centered about and extending in the direction of the axis of motion, and with the second inner piston being located and telescopically slidable within the second engine cylinder along the axis of motion; and a push rod mounted to the first inner piston and the second inner piston and operatively engaging the energy generation and control assembly;

moving the first inner piston along the axis of motion so that the cylindrical side wall covers the at least one exhaust port;

causing combustion within the first engine cylinder that produces exhaust gas;

moving the first inner piston along the axis of motion so that the cylindrical side wall is not covering the at least one exhaust port so that about fifty to seventy five percent of the exhaust gas will flow through the at least one exhaust port; and

moving the first inner piston along the axis of motion so that the cylindrical side wall again covers the at least one exhaust port, thereby trapping the remaining twenty five to fifty percent of the exhaust gas in the first engine cylinder.

11. The method of claim 10 further including the steps of:

moving the second inner piston along the axis of motion so that the second cylindrical side wall covers the at least one second exhaust port;

causing combustion within the second engine cylinder that produces exhaust gas;

moving the second inner piston along the axis of motion so that the second cylindrical side wall is not covering the at least one second exhaust port so that about fifty to seventy five percent of the exhaust gas will flow through the at least one second exhaust port; and

moving the second inner piston along the axis of motion so that the second cylindrical side wall again covers the at least one second exhaust

port, thereby trapping the remaining twenty five to fifty percent of the exhaust gas in the second engine cylinder.

12. A method of operating a free piston engine comprising the steps of:

providing an energy generation and control assembly having a first side and a second side in opposed relation to the first side;

providing a first combustion cylinder assembly located adjacent to the first side and including a first cylinder liner having a generally cylindrical wall that defines a first engine cylinder, which is generally centered about an axis of motion, and with the wall including at least one exhaust port extending therethrough;

providing a second combustion cylinder assembly located adjacent to the second side and including a second cylinder liner having a generally cylindrical second wall that defines a second engine cylinder, which is generally centered about the axis of motion, and with the second wall including at least one second exhaust port extending therethrough;

providing an inner piston assembly including a first inner piston having a head portion, an opposed rear portion, and a cylindrical side wall extending therebetween, with the cylindrical side wall generally centered about and extending in the direction of the axis of motion, and with the first inner piston being located and telescopically slidable within the first engine cylinder along the axis of motion; a second inner piston having a head portion, an opposed rear portion, and a second cylindrical side wall extending therebetween, with the second cylindrical side wall generally centered about and extending in the direction of the axis of motion, and with the second inner piston being located and telescopically slidable within the second engine cylinder along the axis of motion; and a push rod mounted to the first inner piston and the second inner piston and operatively engaging the energy generation and control assembly;

moving the first inner piston along the axis of motion so that the cylindrical side wall covers the at least one exhaust port;

causing combustion within the first engine cylinder that produces

exhaust gas;

moving the first inner piston along the axis of motion so that the cylindrical side wall is not covering the at least one exhaust port so that about sixty to seventy percent of the exhaust gas will flow through the at least one exhaust port; and

moving the first inner piston along the axis of motion so that the cylindrical side wall again covers the at least one exhaust port, thereby trapping the remaining thirty to fourty percent of the exhaust gas in the first engine cylinder.